3. ASSIGNMENT CRITERIA. There are basic criteria for engineering a COMM frequency assignment.

a. Sufficient signal must be provided the aircraft's receiver at a point in the FPSV, furthest from the ground transmitter. That level is -87 dBm, or a 10 mv signal across the 50 ohm impedance at the receiver input terminals. This level assumes a normal ground plane antenna on the aircraft, and only normal (very small) feed line losses. A series of curves for VHF and UHF limits of coverage are found in figures 13 through 24 of this appendix.

b. An interference-free environment level shall be provided the aircraft at all positions in the FPSV. This level is the D/U ratio. ICAO recommends 20 dB D/U, but congestion in this country has required that to be reduced to a lesser but safe level of 14 dB D/U for all ATC functions with station class of FA, FAB, FAC and FLU. In addition, a maximum of -4 dBm out-of-band and a maximum of -104 dBm in-band limit protections are provided from external signals.

c. Transmitter power. Existing policy on transmitter output power is to use 10 W for all transmitters. Use of linear amplifiers is allowed only for those sectors larger than 60 nmi or where AT has operational problems. The need for a 50 W amplifier must be justified in the FMO's application for frequency approval.

d. ATIS, AWOS and ASOS frequency assignment priorities are described in paragraphs 905 and 906 of this order.

4. RLOS. In space, radio signals tend to propagate in a straight line. Near large bodies they tend to "bend" toward the body. In the case of the earth, a sufficiently close approximation of the "effective radio horizon" can be obtained by using the formula in subparagraph a. below which assumes the earth to be 4/3 its actual radius, hence the "4/3 radius" phenomenon. The formula approximation assumes a "smooth" earth, since intervening terrain will stop or attenuate VHF and higher signals.

a. At any given altitude, a transmitted signal will travel only a specific earth distance before it becomes tangent to the earth's radio horizon. Distances beyond the tangency do not ordinarily receive any VHF or higher signals, except under anomalous propagation. Treatises on RLOS can be found in engineering manuals, such as the *ITT REFERENCE DATA FOR RADIO ENGINEERS*, under radio wave propagation. The formula for RLOS is:

$$\boxed{RLOS\ (statute\ miles) = \sqrt{2h}}$$

Where: h = height in feet, AMSL.

or,

$$\boxed{RLOS\ (nmi) = .87\sqrt{2h}}$$

Where: h = height in feet, AMSL.

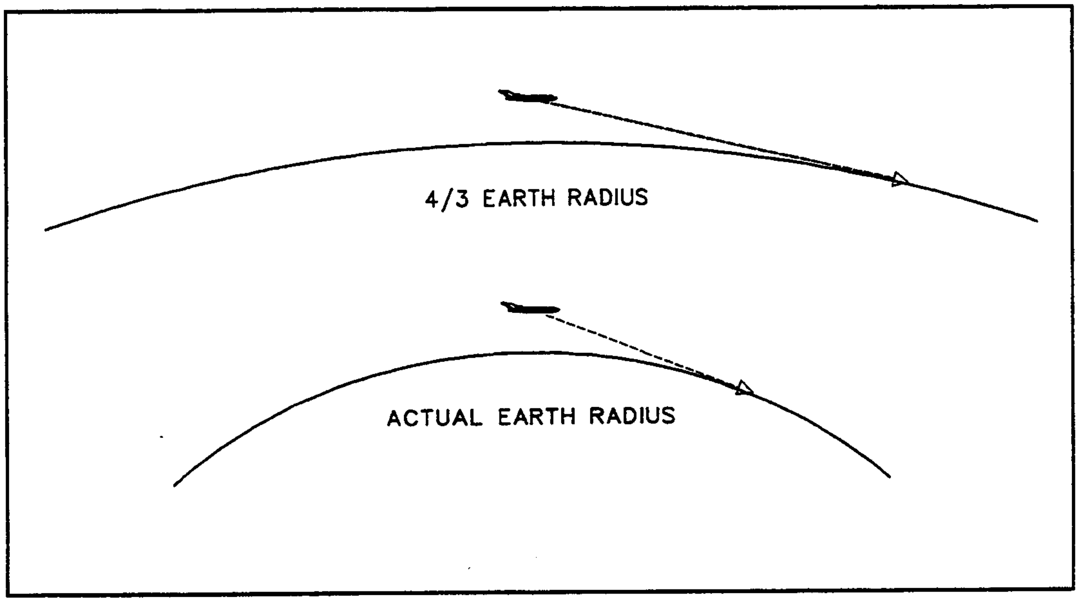
b. Where two elevated sites are involved, the formula is:

$$RLOS\ (nmi) = 1.23\left(\sqrt{h_1} + \sqrt{h_2}\right)$$

Where: h_1 and h_2 are respective point altitudes, in feet, AMSL.

c. A sketch of 4/3 earth radius radio coverage is found in figure 7.

FIGURE 7. COMPARISON OF DISTANCE TO HORIZON FROM THE SAME ALTITUDE BETWEEN ACTUAL AND HYPOTHETICAL 4/3 EARTH RADIUS



5. INTERSITE FREQUENCY ENGINEERING PROCEDURES. These procedures require the determination that at the worst-case, an aircraft will receive a signal from the desired facility 14 dB stronger than from a cochannel undesired facility, that is, D/U = 14 dB. (Adjacent channel will be covered later in this discussion.) The determination is based on the free-space loss formula (L_{fs}):

$$L_{fs}\,(dB) = 37.8 + 20 \log f + 20 \log d$$

NOTE: L_{fs} formula is valid only for distances less than RLOS where:

f = frequency in MHz

d = distance in nmi

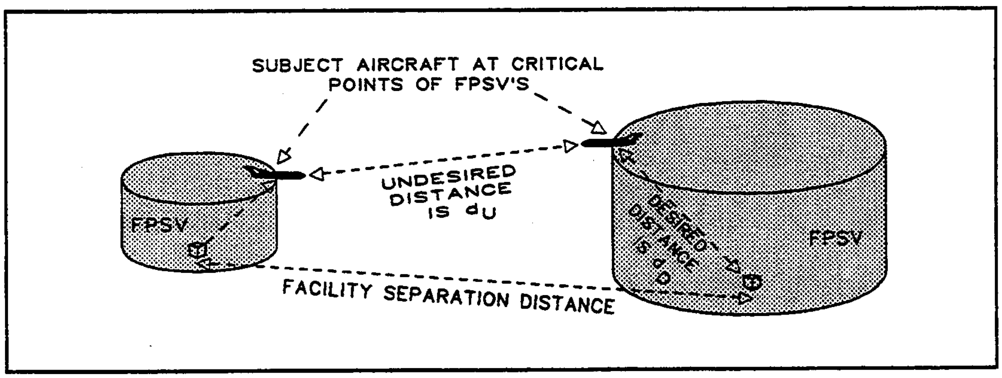
a. Signal voltage (thus current) ratio varies inversely as the distance; the received voltage is only halved at twice the distance.

b. Note that the loss constant and the 20 log f variable are fixed when dealing with a cochannel study. Only the 20 log d varies.

c. Since the 14 dB D/U is determined by the ratio of the distances of undesired to desired sources, d_U/d_D, from the critical point, only the 20 log d need be used to determine required separation (see figure 8). The signal strength D/U is inversely proportional to the distance ratio (DR) from d_U to d_D. The equation becomes D/U = d_U/d_D ³14 dB.

d. The critical point is that point on the edge of the FPSV where an aircraft is simultaneously furthest from the desired facility and closest to edge of a cochannel or adjacent channel FPSV, where another aircraft would be the "undesired signal" D_U.

FIGURE 8. COCHANNEL CONFIGURATION FOR UNDESIRED/DESIRED DISTANCE RATIO



e. In figure 8, to achieve a difference of 14 dB at the critical point, the DR, d_U/d_D, should be 5 or greater or the antilog of 14 divided by 20.

$$20 \log d_U/d_D = 14$$

$$\log d_U/d_D = 14/20 = 0.7$$

$$\text{antilog } 0.7 = 5.01$$

NOTE: When d_U is beyond RLOS, protection will be greater than 14 dB.

f. To complete the analysis, the configuration must now be analyzed with the desired and undesired stations reversed. For the systems to operate properly without interference, both configurations must meet the cochannel criteria.